

## **INTERIM FINAL**

### **Bird Creek Investigation and Injection Well Response Action Plan**

**August 4, 2017**

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#### **ABSTRACT**

In August 2016, the Bureau of Indian Affairs (BIA) informed EPA that a tributary to North Bird Creek had high levels of total dissolved solids (TDS), an oil sheen and bubbles on the surface. EPA conducted extensive investigations in an attempt to determine whether the closest seven (all within 2.0 miles) Class II UIC injection wells (Table 1, Figure 1) were causing the impacts, and if so, through what mechanism. Six of these wells are injecting into the Mississippi Formation, one is injecting into the Mississippi and Arbuckle Formations. Surface water monitoring, both manually and by the use of dedicated in-stream equipment, was conducted, as well as a shallow electrical resistivity survey, aerial photo analysis, and sampling and analysis of surface water and injected fluids. In May 2017, mechanical integrity tests (MITs) were performed on five of these wells (two were shut-in and remain shut-in due to MIT failure) and all of the Authorized by Rule wells (four) were required to submit permit applications. A coordinated shut down of these five wells was performed in June 2017.

Data acquired through multiple approaches support the conclusion that the seven nearby injection wells are causing or contributing to the brine seeps observed in a tributary to Bird Creek.

- Cation/anion analyses using Stiff diagrams (Figure 2) are strongly correlative between brine samples from the seeps and produced brine from the nearby Mississippi Formation oil production/injection operations.
- Additionally, surfactant foam observed at one the seeps is consistent with reported use of surfactants in these nearby operations.
- Mechanical integrity failure and subsequent repair of the Jireh Well 18W (OS6320) in August – September 2016 resulted in a temporary shut-in of this well (for repairs). This action corresponded to a substantial decrease of total dissolved solids over the next several months in Monitoring Station 2, the highest TDS of two “hot spots” (Monitoring Station 6 being the second).
- Mechanical integrity failure identified on the Novy/Grayhorse well in May 2017 resulted in the shut-in of this well. Total dissolved solids at Monitoring Station 2 abruptly dropped even further following the shut-in of the Novy well.
- Simultaneous shut-in of five of the seven injection wells (two of the seven were already shut-in because of mechanical integrity failure) and subsequent measurement of the injection formation pressure in June 2017, demonstrated brine from the Mississippi Formation could not have flowed to the nearby creek without pressure buildup from injection wells.
- Extensive surface water monitoring indicated correspondence of some of the seven injection well operations with surface water brine concentrations, including the simultaneous shut-in event and injection formation pressure measurements mentioned above.
- Finally, air photo analysis with follow-up field investigation confirmed substantial historic salt water contamination of soil dating back to before 1937 in an area very near the brine seeps. This contamination is likely from oil and gas operations and suggestive of a nearby

undocumented wellbore, which could be serving as a conduit resulting in, or contributing to, contamination of the nearby segment of the creek. Shallow resistivity measurements conducted by EPA in September 2016 appear to support this scenario (nearby undocumented wellbore).

While approaches are outlined below, UIC program staff and management strongly recommend and support approach 1, concurrent closure of all seven of the injection wells listed in Table 1. The analysis in this review indicates a loss of containment in the injection formation (the Mississippi Formation) in this area which not only impacts Bird Creek but also endangers the Underground Source of Drinking Water which is present between the Mississippi Formation and the surface.

### **Key Findings**

The analysis of technical data to date indicates:

- Surface water concentrations at the originally reported location (Monitoring Station 2, MS2) have declined steadily and significantly since the Jireh Resources Well 18 (OS6320) was repaired in September 2016 following an MIT failure.
- Further declines at the original location (MS2) also occurred immediately after the shut-in of the Novy/Grayhorse disposal well (OS5258) due to an MIT failure.
- Cation/Anion analysis of injected fluids and high TDS stream waters (Figure 2) show a match with the Mississippi Chat Formation (which is used for both oil production and an injection disposal zone).
- To measure the Mississippi Formation fluid pressure, a concurrent shut-in of the injection wells (Jireh and Warren) of concern (Novy/Grayhorse and Jireh Well 9) were inoperable during the shut-in) occurred on June 9, 2017. Due to the measured static fluids being 500 – 750 feet below ground surface, they cannot flow from depth to the surface without additional pressure buildup, which is provided by the injection operations.
- Monitoring at some locations indicates that despite the repair to the Jireh Well 18W (OS6320) and shut-in (termination) of the Novy/Grayhorse well, injection operations appeared to affect in-stream water quality (TDS) before and after the coordinated shut-in event, but amplitude (degree of variability) of short term concentration fluctuations at some stations diminished during the shut-in period.
  - This indicates ongoing impacts from the injection operations unrelated to the mechanical integrity failures of these two wells.
  - Information to date does not indicate relative impacts from specific injection well(s) or the mechanism of migration responsible.
  - High TDS remains at Monitoring Station 6 (MS6), ½ mile downstream of the original location.

Fresh water aquifers occur in the area down to approximately 500-650 feet, as determined by geophysical well logging techniques. Several domestic water wells were identified near the contamination area (Figure 1), and range in depth from 50-300'. Aquifers (Underground Sources of Drinking Water) are threatened by the injection activity via contamination as the brine moves vertically

upward (through wellbore or fault) to the creek from the Mississippi Formation, and as brine moves to downstream areas where the creek recharges ground water. No existing public water supply wells were identified in the immediate area as of this time. However, the City of Pawhuska has a drinking water intake in Bird Creek, downstream of the brine seeps for its public water supply. Although no impacts were detected to date, this intake has been moved to a nearby lake in a preventative response due to the upstream brine seeps. However, the Bird Creek water supply intake still exists and may be used by the City of Pawhuska at some point in the future (e.g., drought, population increase). Further, with any population growth, other locations on Bird Creek may be relied upon for drinking water.

### **Approaches to Address Injection**

1. Concurrent Closure of All Seven Nearby Injection Wells: Issue termination of authorization to inject letters by 6EN (if possible; immediately shuts wells in) and propose denial/termination of permits (by 6WQ).
2. Staged Well Closures: Issue termination of authorization to inject letters and propose denial/termination of permits in a sequential order.
  - a. Prioritize actions based on same shut-in order used in June (i.e., the high volume, closest active well (Jireh OS6320), first).
  - b. Actions staged in minimum 30 day increments to determine effectiveness.
3. Permanent Termination of Novy/Grayhorse OS5258 Permit and operating restrictions on other wells;
  - a. Restrict authorized injection pressure for remaining six wells to 0 psi (gravity feed only) and allow injected fluid to only include Mississippi Formation water generated at respective operational unit (no disposal, no make-up water).
4. Approach 3 with further restriction of 25% reduction in historical injection volume.
5. Approach 3 with further restriction of 50% reduction in historical injection volume.

***Table 1: Well Info for seven wells within area of interest.***

| Inven-<br>tory ID | Well<br>ID | Owner/<br>Operator | ABR/<br>Permit | Permit No.   | Well<br>Type | USDW<br>Depth<br>(fbs) | Static<br>Fluid<br>Level.<br>(fbs) | S.F.L Date | Latitude  | Longitude  | Distance<br>from<br>MS2 (ft) | Distance<br>from<br>MS6 (ft) | Status |
|-------------------|------------|--------------------|----------------|--------------|--------------|------------------------|------------------------------------|------------|-----------|------------|------------------------------|------------------------------|--------|
| OS5258            | B-15       | Grayhorse<br>/Novy | Permit         | 06S1261P5258 | SWD          | 540                    | 707.35                             | 3/9/2017   | 36.823458 | -96.489383 | 4156                         | 3943                         | SI     |
| OS6320            | 18W        | Jireh              | Permit         | 06S1261P6320 | SWD          | 622                    | 668                                | 6/12/2017  | 36.84119  | -96.504909 | 3800                         | 4948                         | Active |
| OS0921            | B-8        | Warren<br>American | ABR            | TBD          | SWD          | 663                    | 563                                | 6/12/2017  | 36.845139 | -96.496017 | 4715                         | 6493                         | Active |
| OS0922            | 9          | Jireh              | ABR            | TBD          | EOR          | 645                    | 555                                | 6/12/2017  | 36.85202  | -96.507365 | 7731                         | 9030                         | SI     |
| OS5133            | 9B         | Warren<br>American | Permit         | 06S1261P5133 | SWD          | 660                    | 504                                | 6/12/2017  | 36.843278 | -96.496076 | 4111                         | 5884                         | Active |

| Inven-<br>tory ID | Well<br>ID | Owner/<br>Operator | ABR/<br>Permit | Permit No. | Well<br>Type | USDW<br>Depth<br>(fbs) | Static<br>Fluid<br>Level.<br>(fbs) | S.F.L Date | Latitude  | Longitude  | Distance<br>from<br>MS2 (ft) | Distance<br>from<br>MS6 (ft) | Status |
|-------------------|------------|--------------------|----------------|------------|--------------|------------------------|------------------------------------|------------|-----------|------------|------------------------------|------------------------------|--------|
| OS0920            | B7-D       | Warren<br>American | ABR            | TBD        | SWD          | 642                    | 586                                | 6/12/2017  | 36.845045 | -96.4983   | 4715                         | 6340                         | Active |
| OS0924            | 4W         | Jireh              | ABR            | TBD        | EOR          | 637                    | 739                                | 6/12/2017  | 36.844596 | -96.509579 | 5568                         | 6545                         | Active |

fbs = feet below surface measured in injection well.

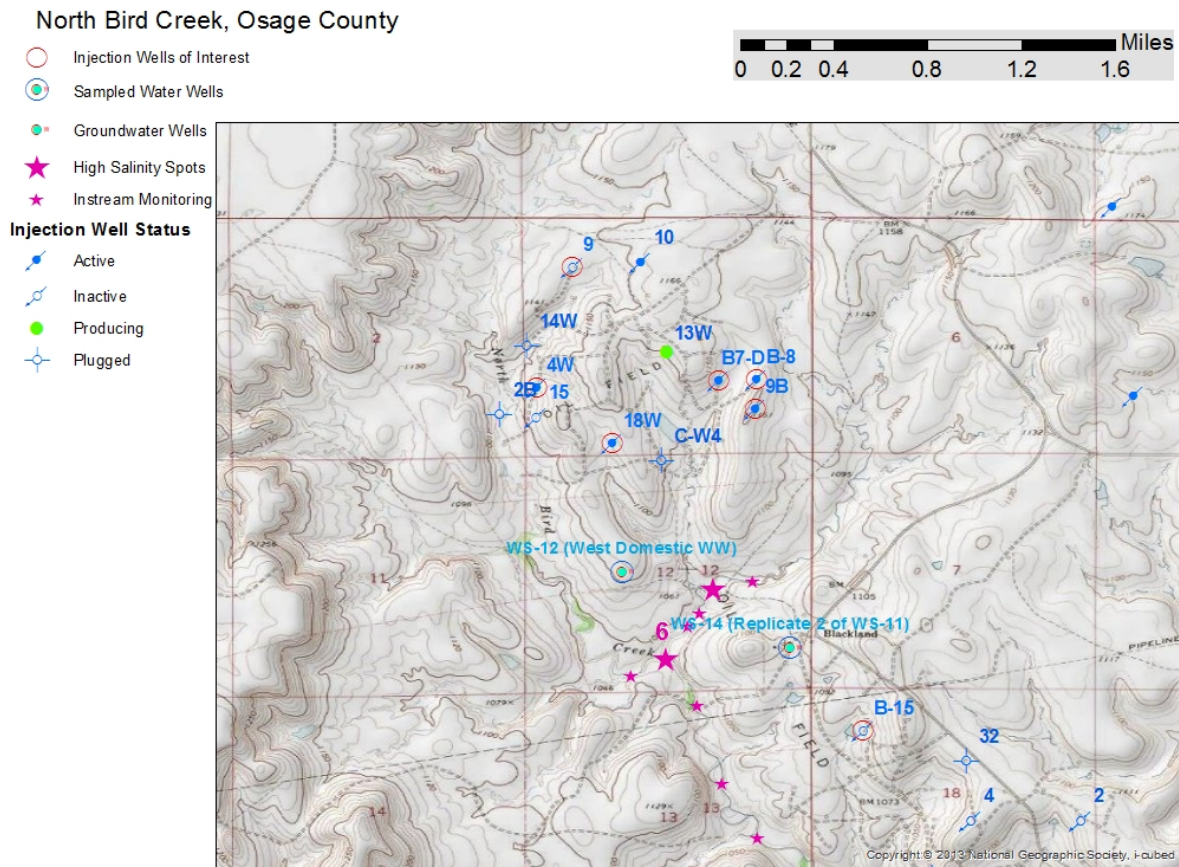
OS0920, OS0921, OS0922 have applied for a permit, but the S.F.L is above the USDW.

OS0922 is currently waiting to do a workover of the well. They have a permit from the BIA, but will not do the work if we deny the permit.

OS5133 permitted 8/8/1986 and reported fluid level of 1147' as recent as 7/8/2016

OS0920 and OS091 have applied for permits as EOR wells.

**Figure 1**



## SUMMARY OF ACTIVITIES AND DEVELOPMENTS

Working in coordination, managers and staff from 6WQ-S and 6EN-W have developed and implemented the following activities regarding the Bird Creek area of concern. This report includes elements related to continuation of current activities and recommended next steps.

Since the confirmation of the impacts to the tributary to Bird Creek at the original location (Monitoring Station 2, MS2) near the ranch road culverts in August of 2016, a second hotspot has been identified (Station 6) and efforts have been made to address three primary questions relating to cause:

- **Are the Bird Creek impacts related to the seven nearby UIC Class II injection wells shown in Table 1?**
- **If so, can we determine the relative contributions from among the seven wells?**
- **What is the mechanism or pathway of fluid migration from them to the surface?**

### Relevant efforts to date have determined:

- Fluids entering the creek are hot, high in total dissolved solids (TDS), and have had, at times, oily sheens and bubbles (which are consistent with some oilfield chemical additives). Multiple measuring locations, both upstream and downstream, have confirmed there is at least one additional location (Monitoring Station 6, MS6, approximately ½ mile downstream of MS2) with high TDS levels and temperatures. No impacts have been detected upstream from the injection wells and the original location.
- The site is remote, with limited access through locked gates. There have been no reported or observed illegal disposal activities. These factors, coupled with the long time-frame of impacts to the creek, and rebounding TDS concentrations after flushing by stormwater, eliminates a surface source due to recent dumping of produced water.
- Anion/cation analysis of the water collected from the initial high TDS location in the creek confirm a geochemical fingerprint (using Stiff diagrams, Figure 2) consistent with produced formation fluids (i.e., brine, salt water) from the Mississippian Formation, which receives injected brine for both disposal and enhanced oil recovery.
- One of the two nearest injection wells is owned by Jireh Resources (well ID 18W, OS6320). It failed mechanical well integrity (at a reported 900' below ground surface (BGS) or shallower). This well was repaired and resumed injection the first week of September 2016. It injects comparatively high volumes of brine (reported up to 80,000 barrels/month).
  - BIA salinity readings collected on a frequent basis at MS2 demonstrated declining TDS values after this repair, dropping from over 80,000 ppm in August 2016 to 15,800 ppm on May 9, 2017.
- The other nearest injection well is owned by Novy Oil and Gas well (well ID 15, OS5258). It is a brine disposal well operated by Grayhorse Operating. On May 4<sup>th</sup>, Osage Inspector Andrew Yates determined, with the operator present, that the well failed mechanical integrity and required repair. Grayhorse shut-in this well on May 9<sup>th</sup> and began attempting repairs. 6EN issued a Termination of Authorization to Inject by letter dated May 24<sup>th</sup>. The operator has not been able to repair the well as of this time. This well had injected comparatively high volumes of brine.

- BIA salinity readings collected on a frequent basis at MS2 demonstrated declining TDS values after this repair, dropping from 15,800 ppm on May 9<sup>th</sup> (date of well shut-in) to 4,900 ppm on May 18<sup>th</sup>.
- The Navy/Grayhorse well received a termination letter from 6EN and remains shut-in as of August 1, 2017, and the operator has notified EPA by email they are likely to plug and abandon the well.
- Five of the seven injection wells in the area passed annulus pressure tests in May, except for the Navy/Grayhorse well and the Jireh 9 well. However, these tests did not address the potential for movement behind the casing in the annular space.
- All of the injection wells were shut-in on Friday, June 9<sup>th</sup>, to allow for collection of static fluid levels beginning Monday, June 12<sup>th</sup>. Mississippian formation fluid levels were measured at approximately 600-700 feet below ground surface. This confirms that under non-injecting conditions, pressure does not exist in the Mississippian Formation in this area at sufficiently high levels to cause migration of formation fluids to the surface. The operators were requested to perform a "staggered startup," with higher priority wells beginning injection first. Other injection wells were requested to restart on a 48-hour interval. It was hoped that the in-stream monitoring of water quality may show measurable impacts associated with the restart. Injection well operation delays effectively prevented the staggered startup from happening as planned. Lower post shut-in volumes being injected by operators have also been reported.
- Initial analysis of the instream monitoring data from May 25, 2017, through July 2, 2017, indicate that in at least three locations, cyclic variations in TDS concentrations appear before the shut-in period, level out during the shut-in period, then resume slowly as injection resumes and formation pressures rebuild after June 15<sup>th</sup>. These data appear to demonstrate a change in water quality in the stream occurs when injection wells are operating. The amplitude (degree of variability) of short term concentration fluctuations at some stations diminished during the shut-in period, especially at MS3. This clearly seems to indicate a correspondence with the injection activities.
- Limited field monitoring (with a hand held probe) of in-stream TDS levels during the start-up of injection activities after shut-in showed only one reading with slightly elevated levels (less than 810 ppm; background was approximately 480-500 ppm) was present in the original location (MS2), but continued to be high (approximately 46,000 ppm) at the downstream location (MS6). This is consistent with the automated in-stream monitoring data.

**At this point, the first question (Are these impacts related to the seven nearby UIC Class II injection wells shown in Table 1?) has been answered with reasonable certainty. Yes.**

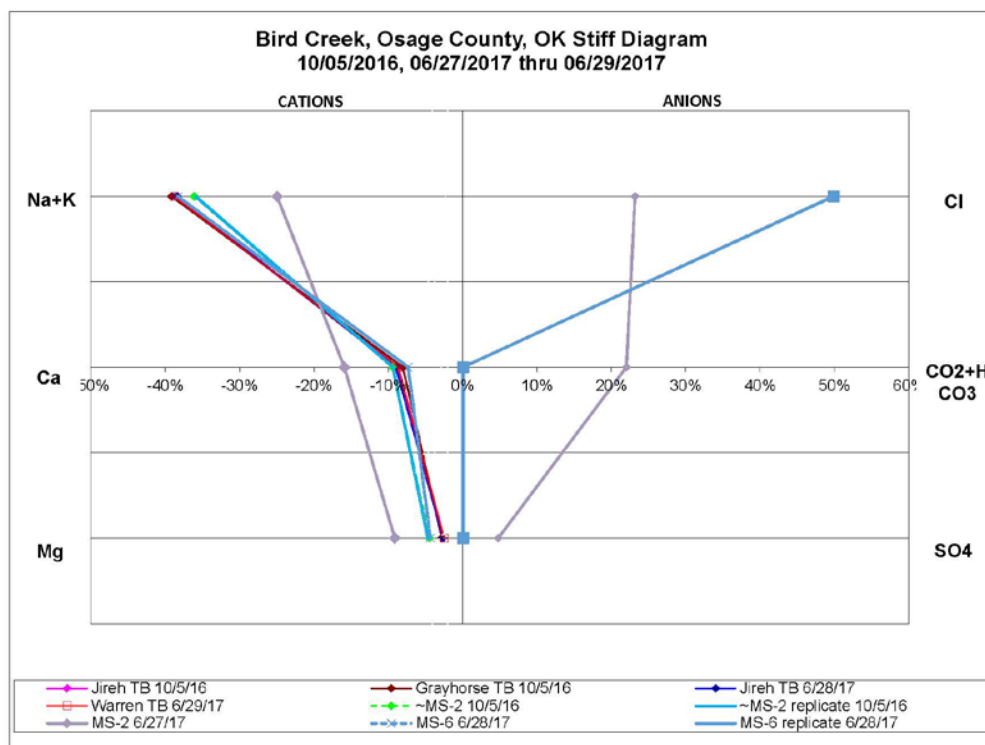
Based on multiple lines of evidence, EPA has concluded that the formation fluids are migrating to the surface under pressure caused by injection well operations.

- The anion/cation samples of brine collected from MS2 (the original location of in-stream impacts) and two of the injection wells is a geochemical match to the Mississippian Formation fluids as indicated by a Stiff diagram (Figure 2).
- Due to the static fluid levels being well below ground surface, Mississippi Formation water cannot migrate from depth to the surface without additional pressure, which can be provided by injection operations.

- The observed oil sheen and bubbles on the surface of the creek are consistent with oilfield additives.
- Based on the remote location with limited access, the persistence of the impacts, the reappearance after flushing by heavy rainfall events, and the lack of any stressed vegetation or witnesses reporting any suspicious activities, recent surface dumping has been eliminated as a potential source. Historic surface dumping prior to 1937 is indicated by aerial photo analysis, but is not considered the primary source of recent contamination events.
- In-stream monitoring data show declining concentrations at MS2 after repair of one injection well and cessation of another. Both wells had failed MITs.
- In-stream monitoring data before, during and after the shut-in of injection operations appears to show a correspondence at multiple locations between cyclic pulses of TDS concentration variations and injection well activities.

At this time, EPA is unaware of any information which contradicts this conclusion.

Figure 2



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Note: some lines on diagram not discernable because of overlap.

**Activities which have been, or may be in the near future, conducted by EPA.**

- In-stream monitoring of the tributary to Bird Creek by automated equipment (i.e., sondes) began in May 2017. Ten monitoring stations (MS) have been established, with data being collected every 15 minutes for conductivity and temperature. At eight of stations, which are located in the deeper parts of the creek, the height of the water column is also being measured by a second, deeper sonde to assess stream flow conditions. Data is recorded within the sondes' onboard memory storage and requires a manual retrieval and download. The first data download occurred the week of June 26<sup>th</sup>. Additional data downloads are expected monthly.
- Water quality samples from the stream were collected the week of June 26<sup>th</sup> to continue to assess impacts for refinement of the conceptual site mode, trend analysis, and exposure control.
- Responses from the information requests sent to operators are being used to select analytes that may help discern whether specific injection wells are sources.
- Surface mapping of electrical resistivity (using the Geometrics OhmMapper™) in the shallow subsurface soils/rock near the original impacted location was conducted on a limited scale in October 2016. Additional mapping with the OhmMapper™ device may be planned for areas of interest in August. This will include targeting the two identified in-stream hot spots (MS2 and MS6), and at least one of three areas identified through aerial photos as having stressed vegetation and high soil salinity levels.
  - Oil and gas drilling in Osage County has occurred since the late 19<sup>th</sup> century, increasing the likelihood of undocumented wellbores that could serve as conduits upward brine flow from deeper formations (<http://www.okhistory.org/publications/enc/entry.php?entry=OS006>). Utilizing historical aerial photography dating as far back as 1937, several local areas of persistently stressed vegetation were identified, possibly indicating past oilfield activity. In recent (June 2017) field screening evaluations at three of these locations, anomalously high salt concentrations (up to 3,300 ppm in solute) were found in shallow soil samples, and salt crystals were observed in the soil at one location. This location (on top of a hill near MS2) is suspected to be in close proximity to an improperly plugged wellbore.
- Soil sampling of the areas with stressed vegetation and high soil salinity levels is planned in conjunction with the electrical resistivity survey.
- Regional staff may utilize a down-hole camera to inspect the casing of the Novy/Grayhorse well (OS5258).
- Research staff at EPA's Ground Water and Ecosystems Restoration Division at the Robert S. Kerr Lab staff in Ada, OK, were consulted on June 27<sup>th</sup> to review information gathered to date and evaluate future actions to identify potential individual sources and migration pathways.
  - Both regional and Ada staff believe dye/tracer studies are unlikely to be useful due to the depth and distances involved in this project, along with numerous geologic uncertainties. The potential for false negatives is very high.
  - It was agreed that utilizing resistivity surveys to identify high conductivity areas due to brine contamination, and/or metallic signatures of well bores, would be preferred. Identifying where the brine is migrating to surface will allow a better understanding of the pathway, potential impacts and risks, and guide further actions.
  - A phased approach initially utilizing Regional personnel and equipment (i.e., the OhmMapper™) could be used to evaluate the areas around the two impacted creek

locations and multiple surface targets identified through historical aerial photograph analysis.

- After results of the shallow resistivity are reviewed, if appropriate areas of interest are identified, a second phase of investigation may be planned, if resources are available. This could be conducted by Ada staff or through Oklahoma State University (contractor support). This phase of investigation will use a traditional resistivity array of very long cables with electrodes fixed into the ground every 10-20 feet. The Ada system (which may not be functional) is capable of evaluating to depths of  $\approx 180$  feet or more, while OSU can reach depths exceeding 300 feet.

**The second and third questions (“If so, can we determine relative contributions from among the seven wells?” and “What is the mechanism or pathway of fluid migration from them to the surface?”) have not been answered conclusively, but information gathered to date is useful in guiding further efforts.**

***Note: It may not be possible to answer these two questions with reasonable certainty with the currently available resources.***

Information that led to the conclusion that the breakouts of brine are related to the injection well operations also informs the Conceptual Site Model (CSM) development. There are two broad initial concepts, both of which involve a horizontal migration from the injection wells to a location nearer the surface impact sites, and then vertical migration, likely through a preferential pathway:

**CSM Approach 1:** Injection of produced brine back into the Mississippian Formation raises the hydrostatic pressure to the point that brine is capable of being pushed to the surface from the Mississippi Formation. Pressure increases causing purges to the creek are believed to originate from multiple injection wells, and under this model would have been transmitted horizontally within the injection zone then vertically along a conduit near the creek. Possible conduits include undocumented wellbores or a fault.

**CSM Approach 2:** Loss of mechanical integrity in injection wells allowed injected brine to enter into a shallower zone (casing leak) and migrate horizontally and possibly vertically, via a preferential pathway(s), to the surface locations. Mechanical integrity can be lost internally (casing, tubing, or packer leaks) or externally (failure of cement behind casing that allows upward flow along the injection wellbore). Internal mechanical integrity is determined by annulus pressure tests, which were conducted on all five of the seven suspect wells in May 2017. UIC Class II program requirements allow cement records for well construction to meet the external mechanical integrity requirement. Region 6 records indicate all seven suspect wells meet the minimum standard for casing cement. The fact that the seep samples so closely match Mississippi Formation water indicates there was little mixing with other formation fluids, as would be expected with great distances of travel through a shallower formation. However, external mechanical integrity failure cannot be ruled out. Other external mechanical integrity testing methods exist and could be required on the suspect wells.

Since no ground surface purges have been identified, the loss of mechanical integrity scenario would require this shallower zone to be a confined or semi-confined formation in order for the injected fluids to transmit enough pressure horizontally to initiate flow to the creek via a nearby vertical conduit. Two of the wells, Jireh Resources EOR well 18W (OS6320) and Novy/Grayhorse disposal well 15 (OS5258) have both lost internal mechanical integrity in the timeframe of interest. The Jireh well was repaired in September 2016, shortly after the confirmation of the surface water impacts by EPA in August. The

Novy/Grayhorse disposal well was found by a field inspector to not have internal well integrity in on May 4, 2017, ceased injections on May 9<sup>th</sup>, and was issued a termination of authorization to inject on May 24<sup>th</sup>. The operator attempted to pull the tubing, but due to massive corrosion, the tubing string broke several hundred feet below the ground surface and the lower section has not been able to be retrieved. The well has not been able to be repaired and remains out of service. The condition of the casing is unknown, but the demonstrated level of corrosive effects on the tubing, along with potential damages during attempts to retrieve the broken injection tubing string, raise serious concerns about the casing integrity.

**Factors Common to Both CSM Approaches:**

- Geologic maps of the area show the presence of multiple faults, supporting the existence of secondary porosity and permeability features (fractures) within the Mississippian formations, which could serve as preferential pathways of injection fluid migration.
- The forensic match (Stiff diagram, Figure 2) shows the in-stream brine originated in the Mississippian.
- Disposal of produced fluids at the surface has been ruled out due to multiple factors.
- The high temperature of the brine in the stream may show it migrates from depth (where it is hot due to the geothermal gradient) to the surface fairly quickly. This would necessitate the presence of a preferential pathway(s) to the surface, which could be an unknown, improperly plugged well bore (or well bores), or an unknown fault or fracture system.
- An alternative explanation of the high temperature in the stream comes from high-salinity solar ponds. Dense brine has been shown to absorb solar radiation much better than fresh water, and has been used as a solar heating system for electrical power generation plants. This solar heating may be creating a pool of hot, dense water in the deeper areas of the stream, thus potentially eliminating the need for a quick migration to the surface from depth through a preferential pathway. However, solar ponds typically use significantly higher salinity concentrations and achieve significantly higher temperatures. Evaluation of temperatures through seasons (and thus shorter vs. longer days and corresponding variations in incoming solar radiation) could help determine the potential for this mechanism to explain the high instream temperatures. If this is the mechanism for heating, a release into the shallow ground water would not require a preferential pathway or confined shallow aquifer zone to explain the high temperature.
- Based on in-stream monitoring before, during and after the shut-in testing, and two mechanical integrity failures (Jireh Well 18W and Novy/Grayhorse (OS5258) well), it appears both the mechanical integrity pathway, and the formation pressure pathway, may be contributing to TDS concentrations in the stream.
- The observed correspondence between brine concentrations in some of the monitoring stations and the nearby injection well operations, considered with recent (May 2017) successful mechanical integrity demonstrations for all operating wells, appears to confirm that a hydrologic connection to the creek exists via a conduit from the injection formation near the creek (undocumented wellbore or fault).

In summary, multiple scenarios exist in terms of pathways from the injection wells to the creek. Due to complexities in the nature of the reservoir (fracture flow), multiple possibilities for conduits, (failed

MITs, undocumented wellbores or faults, etc.), and substantial costs and time, continued efforts to definitively identify the pathway are not feasible.

### **Communication Strategy**

EPA will be contacting the following to ensure that the interested/affected parties are informed: Landowners, operators, Osage Nation, Osage Minerals Council, Solicitor's Office, BIA, City of Pawhuska, Osage County, Cattlemen's Association and Producer's Association.

### **Other Considerations**

- It will likely take a significant amount of time once the source wells are addressed for all salt water seeps to decrease.
- For all response approaches, investigation of additional injection wells (beyond the current seven wells) may be needed if creek salinity levels don't moderate to acceptable level.
- Impacts to all stakeholders (e.g., tribes, operators, landowners) should be considered.
- If impacted oil operators can address the non-containment of the site, they can resume injection operations by re-applying for a permit.
- Annual mechanical integrity tests will be required on any of the seven suspect wells that continue to operate.
- Responsibility for conducting the in-stream monitoring of water quality in the future needs to be determined.

### **Does EPA have the authority to order shut-in of Class II injection wells?**

Underground injection cannot result in the movement of contaminants into an underground source of drinking water. As such, the regulations clearly authorize EPA to order shut-in at both "authorized by rule" (ABR) and permitted wells if the wells fail to confine fluids to its authorized injection zone. The regulations also authorize EPA to terminate a permit if the permitted well activity endangers the environment.

### **40 CFR 147.2903 – Prohibition of unauthorized injection**

- 40 CFR 147.2903(a) – any underground injection, except as authorized by permit or ABR, is prohibited.
- 40 CFR 147.2903(b) – No owner/operator shall construct, operate, maintain, convert, plug, or abandon any inject well or conduct any other injection activity
  - in a manner that allows *the movement of fluid containing any contaminant into underground sources of drinking water,*

- if the presence of that contaminant may cause the violation of any *primary drinking water regulation under 40 CFR Part 142 or may otherwise adversely affect the health of persons.*
- The *applicant for a permit shall have the burden of showing* that the requirements of this paragraph are met.

**40 CFR 147.2912(c) - wells authorized by rule**

- Injection wells or projects which have exhibited failure to confine injected fluids to the authorized injection zone or zones may be subject to restriction of injection volume and pressure, or shut-down, until the failure has been identified and corrected.

**40 CFR 147.2920(d) – wells authorized by permit**

- Injection wells or projects which have exhibited failure to confine injected fluids to the authorized injection zone or zones may be subject to restriction of injection volume and pressure, or shut-in, until the failure has been identified and corrected.

**40 CFR 147.2928 – permit termination**

- 40 CFR 147.2928(a)(3) – permit may be terminated if there is a determination that the permitted activity endangers human health or the environment.